



Journal of Algorithms

Editors: ZVI GALIL • DAVID S. JOHNSON • DONALD E. KNUTH

Editorial Board

L. M. Adleman
J. Bentley
B. M. Chazelle
J. Edmonds
S. Even
P. Flajolet
R. L. Graham
L. J. Guibas
R. M. Karp

D. J. Kleitman
F. T. Leighton
E. M. Luks
G. L. Miller
A. Nijenhuis
A. Odlyzko
M. S. Paterson
N. Pippenger

M. Rabin
R. Sedgewick
E. Shamir
R. E. Tarjan
J. Vuillemin
H. S. Wilf
S. Winograd
A. C. Yao
F. F. Yao

VOLUME 11, 1990



ACADEMIC PRESS, INC.

Harcourt Brace Jovanovich, Publishers

San Diego New York Boston
London Sydney Tokyo Toronto

Copyright © 1990 by Academic Press, Inc.
All Rights Reserved

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the copyright owner.

The appearance of the code at the bottom of the first page of an article in this journal indicates the copyright owner's consent that copies of the article may be made for personal or internal use, or for the personal or internal use of specific clients. This consent is given on the condition, however, that the copier pay the stated per copy fee through the Copyright Clearance Center, Inc. (27 Congress Street, Salem, Massachusetts 01970), for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale. Copy fees for pre-1990 articles are as shown on the article title pages; if no fee code appears on the title page, the copy fee is the same as for current articles.

0196-6774/90 \$3.00

MADE IN THE UNITED STATES OF AMERICA

This journal is printed on acid-free paper.



CONTENTS OF VOLUME 11

NUMBER 1, MARCH 1990

H. EVERETT AND D. G. CORNEIL. Recognizing Visibility Graphs of Spiral Polygons	1
LIWU LI AND T. A. MARSLAND. Probability-Based Game Tree Pruning	27
YUEJIANG HUANG. A New Algorithm for the Generation of Binary de Bruijn Sequences	44
BRENDAN D. MCKAY AND NICHOLAS C. WORMALD. Uniform Generation of Random Regular Graphs of Moderate Degree	52
FRANK RUSKEY AND ANDRZEJ PROSKUROWSKI. Generating Binary Trees by Transpositions	68
DAVID EPPSTEIN. Sequence Comparison with Mixed Convex and Concave Costs	85
MAREK CHROBAK AND TAKAO NISHIZEKI. Improved Edge-Coloring Algorithms for Planar Graphs	102
H. R. MORTON AND H. B. SHORT. Calculating the 2-Variable Polynomial for Knots Presented as Closed Braids	117
JOSEPH NAOR AND MARK B. NOVICK. An Efficient Reconstruction of a Graph from Its Line Graph in Parallel	132
DAVID S. JOHNSON. The NP-Completeness Column: An Ongoing Guide	144
PAPERS TO APPEAR IN FORTHCOMING ISSUES	152

NUMBER 2, JUNE 1990

FRAN BERMAN, DAVID JOHNSON, TOM LEIGHTON, PETER W. SHOR, AND LARRY SNYDER. Generalized Planar Matching	153
V. G. KULKARNI. Generating Random Combinatorial Objects	185
MARK S. MANASSE, LYLE A. MCGEOCH, AND DANIEL D. SLEATOR. Competitive Algorithms for Server Problems	208
E. SCHMEICHEL, S. L. HAKIMI, M. OTSUKA, AND G. SULLIVAN. A Parallel Fault Identification Algorithm	231
MARK ALLEN WEISS AND ROBERT SEDGEWICK. Tight Lower Bounds for Shellsort	242

GUR SARAN ADHAR AND SHIETUNG PENG. Parallel Algorithms for Cographs and Parity Graphs with Applications	252
EYTAN RONN. NP-Complete Stable Matching Problems	285
PAPERS TO APPEAR IN FORTHCOMING ISSUES	305

NUMBER 3, SEPTEMBER 1990

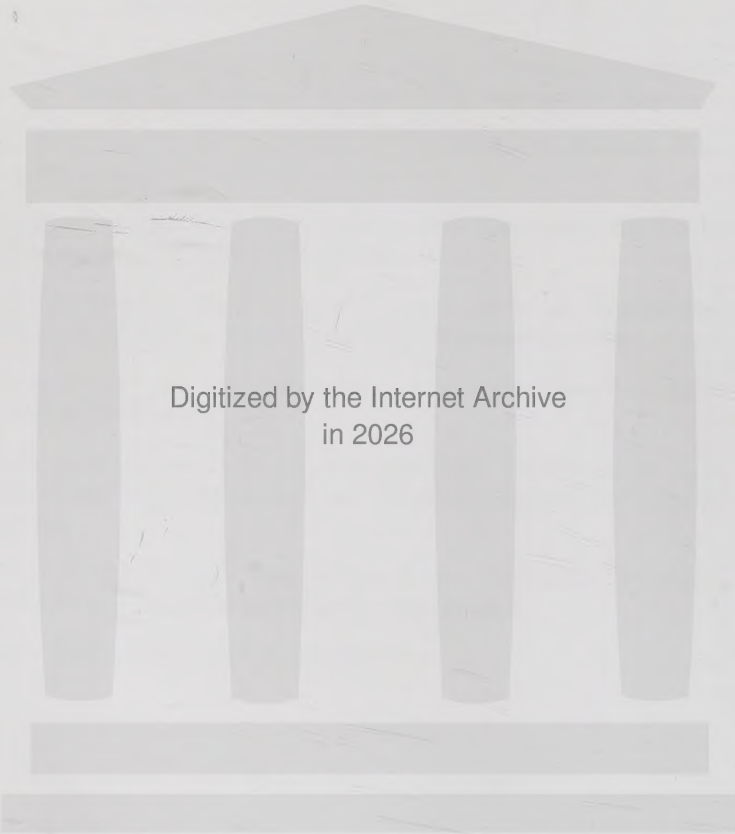
Special Issue on Distributed Algorithms

BARUCH AWERBUCH, AMOTZ BAR-NOY, NATHAN LINIAL, AND DAVID PELEG. Improved Routing Strategies with Succinct Tables . . .	307
BARUCH AWERBUCH. On the Effects of Feedback in Dynamic Net- work Protocols	342
GIL NEIGER AND SAM TOUEG. Automatically Increasing the Fault- Tolerance of Distributed Algorithms	374
OFER BIRAN, SHLOMO MORAN, AND SHMUEL ZAKS. A Combinato- rial Characterization of the Distributed 1-Solvable Tasks	420
JAMES ASPNES AND MAURICE HERLIHY. Fast Randomized Consen- sus Using Shared Memory	441
DAVID B. JOHNSON AND WILLY ZWAENEPOEL. Recovery in Dis- tributed Systems Using Optimistic Message Logging and Check- pointing	462
MING-DEH A. HUANG AND SHANG-HUA TENG. Security, Verifiabil- ity, and Universality in Distributed Computing	492
PAPERS TO APPEAR IN FORTHCOMING ISSUES	522

NUMBER 4, DECEMBER 1990

WILLIAM M. KANTOR. Finding Sylow Normalizers in Polynomial Time	523
DAVID M. MOUNT AND RUTH SILVERMAN. Packing and Covering the Plane with Translates of a Convex Polygon	564
DENNIS SHASHA AND KAIZHONG ZHANG. Fast Algorithms for the Unit Cost Editing Distance between Trees	581
YISHAY MANSOUR AND LEONARD SCHULMAN. Sorting on a Ring of Processors	622

HANS L. BODLAENDER. Polynomial Algorithms for Graph Isomorphism and Chromatic Index on Partial k -Trees	631
JOHAN HÅSTAD. Tensor Rank Is NP-Complete	644
PAPERS TO APPEAR IN FORTHCOMING ISSUES	655
AUTHOR INDEX FOR VOLUME 11	657



Digitized by the Internet Archive
in 2026

JOURNAL OF ALGORITHMS

Instructions for Authors

The *Journal of Algorithms* welcomes papers on algorithms that are inherently discrete and finite and that have some definite mathematical content in a natural way, either in their objective or in their analysis. Most welcome will be new algorithms and data structures, new analyses or comparisons of known algorithms, complexity studies, and sharply focused review articles of subject areas that are currently active. Among these areas are complexity theory, algorithms on graphs, combinatorial searches and objects, discrete optimization, geometric algorithms, arithmetic algorithms, and methods of algorithmic analysis. The Journal will also include a Problems section.

Manuscripts on NP-completeness and related subjects should be sent to **Dr. David S. Johnson, AT & T Bell Laboratories, Murray Hill, New Jersey 07974**. All other manuscripts should be sent to **Professor Zvi Galil, Department of Computer Science, Columbia University, New York, New York 10027**. Graphs and figures submitted must be of professional quality; see **Figures** below for details.

Problems should be submitted to: **Dr. Peter van Emde Boas, Departments of Mathematics and Computer Science, University of Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands**.

Original papers only will be considered. Manuscripts are accepted for review with the understanding that the same work has not been and will not be nor is presently submitted elsewhere, and that its submission for publication has been approved by all of the authors and by the institution where the work was carried out. It is further understood that any person cited as a source of personal communications has approved such citation; written authorization may be required at the Editor's discretion. Articles and any other material published in the *Journal of Algorithms* represent the opinions of the authors and should not be construed to reflect the opinions of the Editors or the Publisher.

Authors submitting a manuscript do so on the understanding that if the manuscript is accepted for publication, copyright for the article, including the right to reproduce the article in all forms and media, shall be assigned exclusively to the Publisher. The Publisher will not refuse any reasonable request by the author for permission to reproduce any of his or her contributions to the journal.

Manuscripts should be prepared according to the following style rules. Deviation from these rules causes publication delays.

Form of Manuscript. Submit manuscripts in duplicate, including the original typewritten copy, preferably triple-spaced, but at least double-spaced, on one side of 8.5 × 11-in. white paper. Number each page. *Page 1* should contain the article title, authors' names, and complete affiliations. At the bottom of page 1 place any footnotes to the title, indicated by superscript *, †, ‡. *Page 2* should contain a proposed running head (abbreviated form of the title) of less than 40 characters and the name and mailing address of the author to whom proofs should be sent.

Abstract. *Page 3* should contain a short abstract (approximately 150 words).

List of Symbols. *Page 4* should be a complete typewritten list of symbols used, identified typographically, not mathematically. This list will not appear in print but is *essential* in order to avoid costly corrections in proof. If the equations in text are handwritten, the symbols list

should be handwritten as well. Distinguish between "oh", "zero"; "ell", "one"; "kappa", "kay"; "vee", "nu"; upper- and lowercase "kay"; etc. Also indicate when special type is required (e.g., German, Greek, boldface, script); all other letters in formulas will be set italic.

Tables. Tables should be numbered consecutively with Arabic numerals in order of appearance in the text. They should be typed double-space and each table should be typed on a separate page. A short descriptive caption should be typed directly above each table and any necessary footnotes (indicated by superscript lowercase letters) should be typed directly below the table.

Figures. Figures should be numbered consecutively with Arabic numerals. All legends are to be typed consecutively on a separate sheet. All figures should be planned to fit the proportions of the printed page (4.5×7.5 in.). Lettering on the original figure should be large enough to be legible after reduction (approximately 50 to 60%). *Differences in type size within a single figure should be no more than approximately 15%.* Standard mechanical lettering sets should be used. Characters should be approximately $3/16$ -in. high (Leroy lettering size 140). *In addition, symbols used to identify points within a graph should be large enough that they will be easily distinguishable after reduction.* Graphs should be plotted with black India ink on white paper no larger than 8.5×11 in. Grid lines that are to show must be inked in black.

Photographs must be kept to a minimum. Halftones should be submitted in duplicate. Halftones should be submitted not larger than 6.5×4.5 in. Magnifications should be indicated in the figure legends.

Equations. All equations should be typewritten and the numbers for displayed equations should be placed in parentheses at the right margin. References to equations should use the form "Eq. (3)" or simply "(3)". Superscripts and subscripts should be typed or handwritten clearly above and below the line, respectively. Use the exponent $1/2$ wherever possible.

References. Follow the styles shown in the following examples:

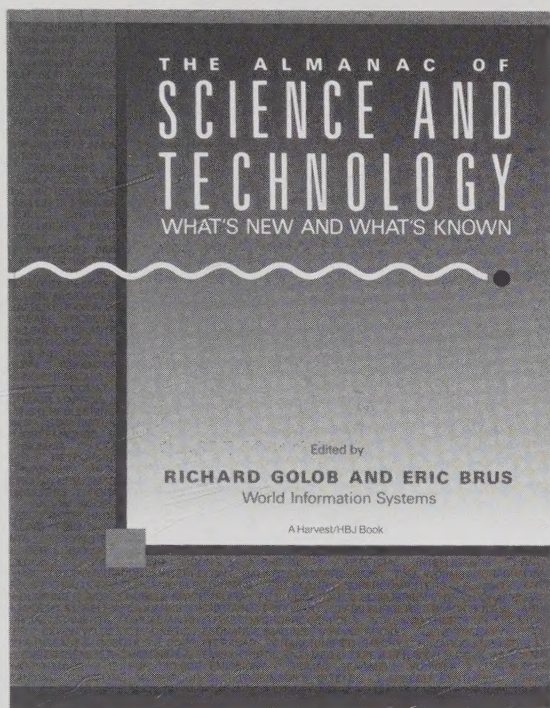
1. R. P. ANSTEE, An algorithmic proof of Tutte's f -factor theorem, *J. Algorithms* 6 (1985), 112-131.
2. M. O. RABIN, Probabilistic algorithms, in "Algorithms and Complexity: New Directions and Recent Results" (J. F. Traub, Ed.), pp. 21-39, Academic Press, New York, 1976.
3. T. H. WITTEN, "Principles of Computer Speech," Academic Press, New York, 1983.

For unpublished lectures or symposia, include the title of the paper, the name of the sponsoring society in full, and the date. For journal names, follow "Abbreviations of Names of Serials" reviewed in *Mathematical Reviews (Index of Mathematical Papers, Volume 20, pp. J1-J31, American Mathematical Society, 1988)*. Cite references in the text by an Arabic number between square brackets, as [1], [1, 2], [1, Theorem 5], etc. Type references double-spaced throughout.

Footnotes. In text, footnotes should be avoided if at all possible. If they must be used, identify them by superscript Arabic numerals in order of their appearance and type them together on a separate page, double- or triple-spaced.

Proofs. Proofs will be sent to the author, with a reprint order form. Authors will be charged for alterations in excess of 10% of the cost of original composition.

Reprints. Fifty reprints (without covers) of each article will be provided free of charge. Authors may purchase additional reprints; an order form will be included with the proofs.



"The Almanac will have enormous educational value for a wide audience, ranging from high school students to professional scientists. The book is both accessible and comprehensive."

—Jay A. Winsten, Ph.D.

Assistant Dean, Harvard School of Public Health
Director, Center for Health Communication

"An impressively thorough, accessible, and up-to-date guide to the hottest areas in the major fields of science." —*Kirkus Reviews*

"Superb!" —Dudley Herschbach, Baird Professor of Science, Harvard University



Harcourt Brace Jovanovich, Publishers

NY-1

For telephone orders,
call toll-free 1-800-543-1918
Available in hardcover and paperback

New in 1990



Journal of Visual Communication and Image Representation

EDITORS-IN-CHIEF

Yehoshua Y. Zeevi

Technion-Israel Institute of
Technology, Haifa
and CAIP Center
Rutgers University
Piscataway, New Jersey

T. Russell Hsing

Bell Communications Research
Morristown, New Jersey

The **Journal of Visual Communication and Image Representation** publishes papers on the state-of-the-art of visual communication and image representation with emphasis on novel technologies and theoretical work in this multidisciplinary area of pure and applied research.

Specific areas of interest include, but are not limited to, all aspects of:

- Image scanning, sampling, and tessellation
- Image representation by partial information
- Local and global schemes of image representation
- Analog and digital image processing
- Fractals and mathematical morphology
- Image understanding and scene analysis
- Deterministic and stochastic image modeling
- Visual data reduction and compression
- Image coding and video communication
- Biological and medical imaging
- Early processing in biological visual systems
- Psychophysical analysis of visual perception
- Astronomical and geophysical imaging
- Visualization of nonlinear natural phenomena

All submissions will be peer-reviewed prior to acceptance.

Submit manuscripts in quadruplicate to:

Journal of Visual Communication and Image Representation

Editorial Office: Seventh Floor, 1250 Sixth Avenue, San Diego, California 92101 U.S.A.

Volume 1 (1990), 2 issues
ISSN 1047-3203

Institutional Rate

In the U.S.A. and Canada: \$64.00
All other countries: \$77.00

Sample copies and
privileged personal rates
are available upon request.
For more information,
please write or call:



ACADEMIC PRESS, INC.

Journal Promotion Department
1250 Sixth Avenue
San Diego, CA 92101, U.S.A. (619) 699-6742

All prices are in U.S. dollars and are subject to change without notice.

S0305